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PAPER

IN

MINERALOGY.

FLINTSHIRE MILL-STONES.

The smaller, or Isis Gold Medal, *was this Session voted to Mr.* W. Bishop *and Co. of Nant y Moch, near Holywell, Flintshire, for their Discovery and Introduction to actual Use of a* Mill-stone *of superior quality, found in Halkin Mountain, Flintshire.*

THE qualities which fit a stone for grinding corn, especially wheat, are hardness, to prevent it as much as possible from wearing down by the constant friction to which it is exposed, a certain degree of tenacity, to prevent the grinding surface from scaling or chipping off, and a cellular structure, in order to increase the quantity of cutting surface, the walls of the cells being at the same time thick enough to resist the strain upon them.

The advantages hence resulting are, that the flour is in no material degree contaminated by the mixture of earthy particles abraded from the stones, the grinding is expeditiously performed, the bran is completely disengaged from the flour, and the flour itself is very little heated by passing through the mill. This latter circumstance is of great importance, it being found, by experience, that flour over-heated, or *killed*, as the technical phrase is, will never produce bread so light as that which is ground cool.

In some parts of the valley of the Seine and of the adjoining districts in which the fresh-water limestone occurs, is found a siliceous rock, in detached masses or blocks, of various size, known on the spot and in commerce by the name of *Buhr*. It is a substance intermediate between hornstone and chalcedony, and possesses, in an eminent degree, the qualities which peculiarly fit it for grinding wheat. All the fine flour required for the supply of the metropolis and of the other large towns in this island is prepared by means of millstones of French buhr, a circumstance which, beside rendering us dependant on foreigners for so essential an article, is the occasion in time of war of enormously enhancing the price, and subjecting our millers to great inconvenience.

The northern shore of the Isle of Wight is the only district in this country in which the fresh-water limestone has hitherto been found, but it does not appear to contain any buhr-stone. The entrochital chert or hornstone (vulgarly called *screw-stone)* which occurs interstratified with the mountain limestone in Derbyshire, as it resembles buhr-stone in quality and texture, has occasionally been made trial of for a grinding-stone, but always unsuccessfully on account of its fragility and softness.—*Sec*.

In the year 1816 Mr. Thomas Hooson, of Flint, observed on Halkin mountain a bed of remarkably fine Porcelain clay, which, on exposure to the potters' fires was found to assume a more delicate whiteness than any substance of a similar nature hitherto found in this kingdom; and seeing also other substances which he thought likely to be useful to the potters, he obtained from Earl Grosvenor a lease of all clays, rocks, and stones (except lime-stone) within his lordship's liberties; and subsequently, with a view to an extended trade, formed his present partnership with Mr. Richard Fynney, Mr. William Bishop, and Mr. James Whitehead, established under the firm of the "Welsh Company at Nant y Moch, near Holywell," where they have erected works for preparing the clay, which is called "Cambria," for sale, by separating it from a white siliceous sand and rock, with which the bed is found mixed to a depth at present unknown, but which has been proved as deep as 26 yards. The sand, when separated, is used for glass-making; and the white siliceous rock, now called "Rock Cambria," is ground down and used in the composition of China and earthenware, instead of ground flint, or is mixed with it. For this process of grinding, several thousand tons of chert are annually consumed in the Staffordshire potteries, and much is supplied from Halkin mountain. In quarrying this chert, some of it in the state of vesicular entrochital horn-stone was raised, which, when used together with common chert, indicated such a superiority by its expeditious grinding and its little wear, and showed such a proximity in appearance (after having been worked) to the French buhr; that its use for grinding wheat was considered probable; and this led to the first application of the vesicular Halkin rock as a buhr-stone.

Halkin Mountain (called "Alchene" at the Conquest, according to Pennant) is a range of high uncultivated land, in Flintshire, the mineral property of the right honourable Earl Grosvenor. On the inland side it runs parallel to the boundary hills of the vale of Clwyd; and on the north-east stretches from Holywell for about four miles till nearly opposite Northop, in an angle of about twelve degrees with the river Dee, and averages about a mile in breadth. It is composed of mountain limestone, with the usually accompanying rocks, and abounds with large veins containing lead ore, blende, and calamine, with some appearances of copper; it also affords a rock of a whitish quartz, well adapted for certain kinds of mill-stones, for which (according to all our old historians) Flintshire has been famous. But these quarries had been neglected for many years, till lately re-opened by the discoverers of the still more valuable buhrs, and promise to regain their celebrity as grey stones for grinding oats, &c.

The buhr-stone itself, or entrochital horn-stone, is found near the middle of the eastern ridge of Halkin mountain, and on the west side of the ridge, into which it penetrates with a dip of about one yard in six. Its present appearance presents a bed of about four yards thick, between two layers of a compact siliceous slaty chert, covered with a shivery siliceous shale. It dips eastwardly, like all the other strata on the mountain, which consist of lime-stone rock and chert. The buhr-stratum is principally of the same quality as the small mill-stone sent herewith, and attested by Dr. Traill (certificate, No. 1); but rotten masses sometimes occur, and blocks are occasionally found of too close a texture for the miller; and some few are quite solid. Still the corallite structure pervades the whole: the entrochites being perfect and entire in some instances, while in the chief parts of the bed the casts alone remain; thus leaving the rock vesicular, and in this respect differing from the nature of the pores in the French buhr, which appear to have been caused by corrosion, their edges being rusty and impure, whereas those in the Halkin buhrs are of pure flint, and exceedingly sharp and hard.

The quarry from which all the buhrs hitherto used have been procured, now presents a fore-breast of forty yards, and is of the same quality and thickness as at first, but has a thicker covering of shale as it dips into the hill. At the distance of a mile to the north-west, a second quarry is now opening, and appears similar in every respect to the former; and from fragments of buhr here and there found, with pieces of shale and of chert, half concealed in the mountain turf, traces of the same stratum may be observed from the one quarry to the other. About half a mile to the south-east of the main quarry, in the same chert-formation, the buhr-stone is also seen to crop out; and in the valley at the foot of the ridge, where a thick bed of lime-stone forms the upper stratum, with a sub-stratum of chert, the miners, in their search for lead-ore, have met with the buhr-stone at the depth of 160 yards from the surface.

In order to prove the Halkin buhrs, the discoverers had some made into mill-stones, which they set up in a neighbouring mill in the borough of Flint; some were had by a millwright, and afterwards sent to a mill at Dunham-o'-th'-Hill, mixed with French buhrs; and one large buhr was shaped into a millstone, and put up at a mill at Ysceifiog.

They considered it would require much time to prove the real character of the buhrs, and that it would be useless to endeavour to make sales till this proof could be satisfactorily made, and therefore they took but little trouble in circulating the object of their discovery for nearly two years, when finding that the stones at Flint mill were highly approved, and found to be a substitute for the French buhrs, they turned their attention to the subject.

They were advised to lay specimens of the buhrs before the Society of Arts, &c. immediately, lest they might be anticipated by some other person in their pretensions to the premium offered, and they accordingly ventured to do so, in February 1820 (under the name of Flint Buhrs), but not having then had sufficient trial made of them, they were not in possession of certificates sufficiently extensive on which to rest their claims to the notice of the Society.

As, however, they are now able to adduce proofs that the Halkin buhrs are fully equal to the French, and in some cases are declared to be actually superior to them, they trust that the Society, in looking to the national importance of the discovery, will pass over the trouble that was last year so unintentionally occasioned, and again take the matter into their consideration.

They request permission to lay before the Society the accompanying certificates and letters on the subject; and in order to show that they have not been selecting a few, and withholding any less favourable to their hopes, they beg to state the result of every sale made by them up to the end of the last year, and to add a short review of the particular certificate connected with each case, observing at the same time that not one unfavourable or unsatisfactory trial has yet occurred.

Some of the buhrs got on the discovery of the quarry were (as before stated) converted into millstones, and put up about three years ago at Mr. Evans's mill, in the borough of Flint, who certifies that "he used them nearly two years occasionally for wheat, but chiefly as grey-stones, in which they excelled; that at first he used them seldom for wheat, but afterwards more and more frequently, as he found them answer the purpose; and, by way of comparing them with the French stones, he took six measures of wheat, and ground one-half on the Halkin stones, and one-half on the French stones; there was some very slight difference in the flour, which was in favour of the French; but hè did not consider it as a fair trial, as the Halkin stones were not at the time properly faced for wheat grinding, and if the French stones had been faced as rough, the flour from them would not have been better than the other. Bread was made from the two kinds of flour, but no one could distinguish between the two. He then had the Halkin stones regularly faced and crached as French, and has found them ever since equal to the French stones in every respect whatever."

Others of the buhrs, got about the same time, were used more cautiously by a millwright, who made a large pair of millstones of Halkin and French buhrs, fixed in alternately, and these were set up more than three years ago at the Horn-mills, near Dunham-o'-th'-Hill, in Cheshire. Mr. John Peers, the present tenant of this mill, entered on it nearly three years ago, and he states that "the stones were in a rough state, and required six months to get them to a proper face, when they ground wheat as well as the best French stones, and have ever since continued to do so; that he prefers the Halkin and French stones mixed to those of French buhrs entirely, as they grind faster, and as well, and full as cool as the French; that he uses them for all purposes, and considers them equal in every respect, and superior in some respects to the French buhrs."

A large buhr got about the same time, was sold to Mr. John Edwards, the occupier of a small mill at Ysceifiog, in Flintshire; he states "that from various causes the buhr was not used till about twelve months ago, when he shaped it into a millstone of three feet six inches diameter; that he has no French stones, but used this as a runner over a blue stone for grinding wheat, and found the flour of good colour, and the bran broad and light; that the stone would bear the finest cracking, and continued to improve and harden till he left the mill in November last."

The next sale was to John Dumbell, Esq., of the Mersey Mills, Warrington (said to be the largest establishment in the kingdom, and containing twenty-two pair of millstones), and he certifies that " in March 1820, he received a quantity of Halkin buhrs, which he had forthwith made into millstones, and these were so much approved, that in May 1820 he had buhrs for a second pair; that the two pair of Halkin millstones have been regularly at work ever since, and continue to give great satisfaction to the bakers and flour-dealers; that he conceives they are precisely the same kind of stone as the French buhrs, and cut the grain like them, and are like them in respect to oatmeal, in which neither French nor Halkin stones are used to advantage; and he considers the discovery of great national importance." Messrs. Hurstfield and Passand (now the occupiers of some large mills at Lymm, near Warrington, but who were lately foremen to Mr. Dumbell, and have been practical millers nearly thirty years), state " that they made the Halkin stones which were set up at the Mersey Mills, where there are nine pair of French stones at work; that they made an experiment with some wheat, by grinding some on the best French pair, and some on the Halkin stones, in order to compare the flour, in which there was scarcely any perceptible difference, though the preference was given in favour of the Halkin stones by a corn and flour dealer, to whom the samples were shown; that bread was made from each, but no difference could be perceived; that at first they thought the Halkin stones not quite so hard and tough as the French, but they found them continue to improve, and to become as good as French; that they have seen all varieties of millstones, and made all sorts of millstones, but never saw any buhrs to come in competition with the French, except the Halkins, which they are satisfied will answer every purpose."

In corroboration of these statements, a sample of the bran (sifted in its rough state out of the flour), is respectfully submitted to the Society.

In May 1820 a Halkin millstone was sent to Mr. Pratt, of Saredon Mill (a large concern near Walsall, in Staffordshire), and set to work in his mill at Dudley. Mr. Pratt has had a very extensive practical experience for more than thirty years, and in October last he wrote that "it had been applied for several weeks in grinding wheat, and that it ground equal to French stones, and better than some of them; but he had it for grinding barley, &c., and was so using it, and found it answer remarkably well for that purpose; that the face and dress keep good, and for a great length of time; and that in the Spring he would have a pair of Halkin stones to grind wheat." Upon application to Mr. Pratt for the result of his further experience, he writes again on the 26th February, that "he gave a just report of the good qualities of our Halkin millstone in October last, and entertains the same opinion to the present day; but that it had been grinding barley, &c ever since, and he never before met with any stones to bear hard grinding so well, and continue the dress so long."

In June 1820, Mr. Stephens, the owner and occupier of a steam mill in Harrington, Liverpool, having a desire to try the Halkin buhrs, obtained a buhr, which he broke into several pieces, and fixed them into different parts of a pair of French buhr millstones, and he certifies, that "they have since worked to a good face, and crack as well as the rest of the stones, and as far as his opinion can be formed by such a circumstance, he considers the Halkins equal to the French buhrs." He states also, "that he has, at the request of the discoverers, taken out one of the pieces of Halkin buhr from his millstones," which they beg to offer to the attention of the Society as a convincing proof of the toughness and hardness they manifest after a few months' wear, being in this respect also like the French buhrs.

In August 1820, a pair of Halkin millstones, of five feet diameter, were sent to Messrs. Pilling and Co.'s large mills, at Mirfield, near Leeds, who have not yet given any written report of the stones; but Mr. Goodwin of Liverpool (a mutual friend of Mr. Pilling, and of the proprietors of the quarry), states, that he lately had a conversation on the subject at Mirfield with Mr. Pilling, who stated "that the stones were not quite so uniformly porous as the sample buhr, and had rather chipped in facing; that they mended of this every time they were faced, and were evidently tougher the longer they worked."

[*N. B.* It is intended to send up Mr. Pilling's own report, by way of supplement, as soon as it can be procured.]

In September 1820, a pair of Halkin millstones was put up at the Aughton water-mill, near Ormskirk, Lancashire, occupied by Mr. Richard Rawsthorn, sen. who has been a practical miller all his life, and is 74 years old, and he states, that "they answer better than French, for they grind cool, and make fine flour, cut bran thin and broad, and crack as fine as any French stone."

In September 1820 a Halkin millstone was also put up at a new windmill at Knotty Ash, near Liverpool, and Messrs. Marr, the tenants, declare, that "they laid down a pair of French buhrs, and a short time after laid down a French and Halkin; that the latter work equally well as the French; stand cracking as well, have been dressed four times, and still improve; soften the wheat as well or better than French do, and cut very broad bran, and preserve the colour as well as any French stone."

In October 1820 a pair of Halkin millstones were sent to Messrs. Hudson and Co., of the King's Mills, Leeds. By a letter from them it appears the stones are not yet in use, so that no positive proof can be had of their grinding, but they say "that their millers who have prepared the stones for work (from which they can form a good opinion of their qualities in comparison with French buhrs), give them a favourable opinion that they are likely to answer."

In November 1820 a pair of Halkin millstones were consigned to Richard Robinson, Esq. of the Phœnix Iron Works, Dublin; but they were delayed for a long while by stress of weather, and have not yet been put to work; Mr. Robinson, however, says, that "they have undergone a very close examination by some of the first millwrights and millers, who all agree that they appear equal to the French buhrs, and in some instances superior," alluding (it is supposed) to the equability of the pores.

In December last, Richard Sankey, Esq., banker in Holywell, Flintshire, and owner of a large windmill there, having a pair of French millstones which did not give entire satisfaction, removed the runner, and put up a Halkin millstone in lieu of it, and he certifies, that "his tenants like the work done by these better than by the other pair of French stones in the mill; that they clean the bran better, that the flour is soft and of good colour, and the stone keeps its face well, and gives satisfaction in all respects."

The discoverers beg permission to declare further (and are ready to do so on their oath if desired), that the several certificates above mentioned have been given voluntarily and gratuitously, and that the several persons giving them have no concern or interest in the quarry; and that up to the end of the last year, no Halkin buhrs or millstones have been disposed of in any instance except those before mentioned; namely,

Mr. Edward Evans, Flint Mill, Flintshire.
Mr. Peers, Horn Mills, Dunham-o'-the-Hill, near Overton, Cheshire.
Mr. John Edwards, Ysceifoig, Flintshire.

John Dumbell, Esq., Mersey Mills, Warrington, Lancashire.

Mr. Pratt, Saredon Mill, near Walsal, Staffordshire.

Mr. Stephens, Steam Mill, Hill street, Harrington, Liverpool

Messrs. Pilling and Co., Mirfield Mills, near Dewsbury, Yorkshire.

Messrs. Hudson and Co., King's Mills, near Leeds, Yorkshire.

Mr. Rawsthorn, Aughton Water-Mill, near Ormskirk, Lancashire.

Mr. Marr, Knotty Ash Windmill, near Liverpool.

Richard Robinson, Esq., Phœnix Iron Works, Dublin.

Richard Sankey, Esq., Banker, Holywell, Flintshire.

They have therefore offered to the Society all the evidence which it is possible to produce, and trust that when the various testimonials (collected from different sources and from persons who have had no communication with each other, though all agreeing in approbation) shall have been compared, the Society will be pleased to honour the Halkin Buhrs with their sanction.

W. Bishop & Co.

The several samples alluded to in the preceding report are placed in the Repository of the Society.

CERTIFICATES,

From all the persons named in the preceding statement accompanied the communication of Messrs. Bishop and Co.; of which the following, as being the most important, are subjoined :

N° I.

Liverpool,
March 3rd, 1821.

I HAVE this day examined the small millstone, of Flint buhr-stone, measuring 11½ inches in diameter, which is about to be sent to London for the inspection of the Society of Arts, and hereby certify, that it is a fair specimen of the rock in the quarry on Halkin mountain, which I visited last year; a vast quantity of stone of a quality equally excellent with this specimen, may be procured from Mr. Bishop's quarry on Halkin, in Flintshire.

THOS. STUART TRAILL, M. D.

N° II.

Mirfield Low Mills,
March 7th, 1821.

SIR;

AFTER having tried your Halkin buhr-stones, for a fair and sufficient time, we are now enabled to lay before you a candid and faithful report of their quality; and this we shall endeavour to do, with as much brevity as is consistent with the importance of the subject.

The perfection of grinding consists, in reducing grain to a requisite degree of fineness, with the least pressure; or, in other words, to make the best and the greatest quantity of flour, out of a given quantity of wheat, with the least pressure. But, the mere good quality of a stone cannot effect this; for we must now call in the aid of art. And here it is that the great art of a miller consists, the putting of work into stones, or the obliquity and disposition of the furrows, every thing else compared with this being only trifles. And, indeed, when we consider that an accurate knowledge of this is grounded upon the doctrine of central forces, which constitutes an important branch of the Newtonian philosophy, we need not wonder, that so few understand the real principles of corn grinding. We have, however, reasons to believe, that we have considerably improved it.

From these observations it appears, that though the quality of the stones may be equally good, the effects produced will be different, according as the work is scientifically put in or otherwise; but, if the work and velocity of the stones be the same, we can clearly ascertain the quality of them, by the effects produced.

We will now apply these observations to the stones in question. After twice or thrice taking them up, we were afraid that they would not stand the crack well; but this fear was soon dispelled, as we now find that they wear exceedingly little, and that the crack stands as fine as a hair. We now proceeded to ascertain the quality of the bran compared with our French stones, and for this purpose, we sifted the meal from every pair of stones as it came from the mill-eye; the bran thus retained in the sieve,, we placed by itself, and by this means we had an opportunity of comparing the whole together. This we have repeated no less than forty times, and the result has always been, obviously from the very first glance, that the bran produced from the Halkin buhrs, was not only cleaner, but of a more uniform cut; and this has not been perceived by millers alone, but by every person that has accidentally come into the mill.

This we think is quite sufficient to prove the superiority of the Halkin buhrs; but, that every possible doubt might be removed, we had recourse to the following experiment:

We selected the best French stones in the mill, made by the late Mr. Gardiner of Liverpool, who was very famous for his knowledge of French buhrs; and, that the experiment might be the more accurate, we did not grind a quarter of wheat on each pair of stones, as it is impossible to part it from the wheat that precedes and succeeds with that degree of nicety that is required, without running the stones empty and thereby injuring them very considerably. But we weighed 480 pounds of meal, ground by each pair of stones, from the same wheat, weighing 57 pounds the bushel. These two parcels, after remaining a week, were weighed again, to see if any accession or diminution of weight had taken place; but the weights were precisely the same as before. The two parcels of 480 pounds each were then dressed, and the result was as follows:

Flour from the Halkin Buhrs	390 pounds.
Flour from the French Buhrs	384
Difference in favour of the Halkin Buhrs	6

Now, in this experiment, the velocity and work of the stones being the same, the quality of the buhrs may be as justly inferred from the effects, or quantity of flour produced, as any other cause in philosophy from its effects.

We remain, Sir,
&c. &c. &c.
J. & W. Pilling.